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भारतीय मानक

नम्य तरंग पथक समुच्चय कार्यकारिता

Indian Standard

FLEXIBLE WAVEGUIDE ASSEMBLY PERFORMANCE

UDC 621·372 : 620·16

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1992 **Price Group 9**

Indian Standard

FLEXIBLE WAVEGUIDE ASSEMBLY PERFORMANCE

NATIONAL FOREWORD

This Indian Standard which is identical with IEC Pub 636 (1979) 'Flexible waveguide assembly performance' issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on the recommendation of the Microwave Components and Accessories Sectional Committee and approval of the Electronics and Telecommunication Division Council.

Certain terminology and conventions are not identical with those used in Indian Standard, attention is especially drawn to the following:

a) Comma (,) has been used as decimal marker while in Indian Standards the current practice is to use a point (.) as decimal marker.

b) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

c) For the purpose of this Indian Standard, only the metric dimensions are applicable.

CROSS REFERENCES

In this Indian Standard, the following International Standards are referred to. Read in their respective place the following:

International Standard	*Indian Standard*	*Degree of Correspondence*
(IEV) IEC Pub 50 (62) Waveguides	IS 1885 (Part 56) : 1981 Electrotechnical vocabulary : Part 56 Microwave components and accessories	Technically equivalent
IEC Pub 68 Basic environmental testing procedures	IS 9000 Basic environmental testing procedures for electronics and electrical items	Technically equivalent
IEC Pub 153-2 Hollow metallic waveguides, Part 2 Relevant specifications for ordinary rectangular waveguides	IS 4493 (Part 2) : 1981 Specification for hollow metallic waveguides: Part 2 Ordinary rigid rectangular waveguides	Technically equivalent
IEC Pub 154-2 Flanges for waveguides, Part 2 Relevant specifications for flanges for ordinary rectangular waveguides	IS 10738 (Part 2) : 1990 Flanges for waveguides: Part 2 Flanges for ordinary rectangular waveguides	Technically equivalent
IEC Pub 374 Guide for choosing modular dimensions for waveguide components	IS 13246 : 1991 Guide for choosing modular dimensions for waveguide components	Identical

Only the English language text in the International Standard has been retained while adopting it in this Indian Standard.

NATIONAL EXPLANATORY NOTES

1. In National context, for clause 1.2 Type Designation, reference indication:

'*a*) 636 IEC —' is not relevant.

2. In clause 4.1 the test for gas tightness has been specified. If applicable, reference shall be made to IS 9817 : 1981 'Sealing test for pressurized waveguide tubing and assemblies (*first revision*)'.

3. In this standard, the ambient test temperature of 20°C has been specified. Standard reference Indian temperature of 25°C shall be used, where applicable.

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When necessary, this standard takes into account IEC Publication 68, Basic Environmental Testing Procedures.

SCOPE

This standard applies to the recommended types of flexible waveguide assemblies whose principal characteristics are given in Tables I and II, pages 33 to 35.

OBJECT

The object of this standard is to define the principal electromechanical characteristics and test methods enabling the performance of the recommended types of flexible waveguide assemblies to be verified.

APPLICATION PRECAUTIONS FOR THIS STANDARD

Preformed assemblies will not necessarily retain in full the mechanical and electrical properties specified in the tables. However, the tables will serve as a guide to the user when considering the minimum bending radii obtainable and the electrical performance that can be expected from a preformed assembly in its relaxed position.

This standard does not apply to combinations comprised of rigid and flexible waveguide assemblies, to special components such as those with additional cooling facilities, or to those subjected to high internal pressure.

This standard contains flexibility and twistability values for "repeated", "field" and "preformed" applications. Normally, it is not intended that any one assembly should be subjected to more than one type of usage. If mixed usage is considered, the manufacturer must be consulted before an estimate of usable life can be made since the full mechanical and electrical properties specified herein may not apply.

Clause No.	Item
1.	**General**
1.1	*Terminology*
1.1.1	*Technical terms* Except for the technical terms defined in this standard, the terms used are in accordance with the International Electrotechnical Vocabulary (I.E.V.), IEC Publication 50(62), Waveguides. For the purposes of this standard, where no possible ambiguity exists, any flexible waveguide assembly defined herein will be referred to as an "assembly". *Note.* — The assembly shall mate electrically and mechanically with a corresponding standard rigid waveguide assembly.
1.1.1.1	*Flexible waveguide assembly* A section of either twistable or non-twistable flexible waveguide tubing together with its associated jacket, flanges and fittings attached.
1.1.1.2	*Twistable assembly* A flexible waveguide assembly capable of accommodating bending, tensile, compressive or torsional stresses. *Note.* — When suitably mounted, the assembly will not suffer mechanical damage or degradation of electrical performance providing the limitations specified in Table I are not exceeded. If the assembly is subjected to a simultaneous combination of these stresses, the values given in the table are not applicable.
1.1.1.3	*Non-twistable assembly* A flexible waveguide assembly capable of accommodating bending, tensile or compressive stresses acting separately or in any combination, but specifically excluding all torsional stresses. *Note.* — When suitably mounted, the assembly will not suffer mechanical damage or degradation of electrical performance providing the limitations specified in Table I are not exceeded. If the assembly is subjected to a simultaneous combination of these stresses, the values given in the table are not applicable.
1.1.1.4	*Preformed assembly* A flexible waveguide assembly formed in the manufacturer's plant to its final shape. *Note.* — The final shape shall be previously agreed upon between the contracting parties.
1.1.1.5	*Corresponding standard rigid waveguide* The ordinary rectangular waveguide which will mate electrically with a flexible waveguide assembly conforming to this standard.

Clause No.	Item
1.1.1.6	*E-plane* By convention, the longitudinal plane of symmetry perpendicular to the broad face of the assembly.
1.1.1.7	*H-plane* By convention, the longitudinal plane of symmetry parallel to the broad face of the assembly.
1.1.1.8	*Full bandwidth* The operating frequency range of the corresponding standard rigid waveguide in the dominant mode. *Note.* — This corresponds to Class F in Table II.
1.1.1.9	*15% bandwidth* 15% of the full bandwidth. *Notes 1.* — The centre frequency shall be agreed between the contracting parties, and 7.5% of the full bandwidth added to and subtracted from this frequency to define the limits of the bandwidth at 15%. *2.* — This will be associated with a smaller reflection factor.
1.1.2	*Terms relating to testing procedures*
1.1.2.1	*Relaxed position* The position of an assembly when it is restrained only by a horizontal surface on which it rests and is subject to no force except that imposed by gravity.
1.1.2.2	*Flexibility-attenuation class* Three flexibility-attenuation Classes A, B, and C are specified. No order of performance standard is implied and it is left to the user to specify that class which will meet his own particular operational requirements. The values for the minimum bending radius, *R*, in Table I are based on the internal broad dimension of the corresponding standard rigid waveguide, the flexibility-attenuation class, and the severity of the bend to which the completed flexible waveguide assembly may be subjected.
1.1.2.3	*Minimum bending radius* The radius measured to the centre and longitudinal line of the waveguide, to which an assembly can be bent in the appropriate plane and under the conditions indicated in Sub-clauses 1.1.2.4, 1.1.2.5 and 1.1.2.6.
1.1.2.4	*Minimum preformed bending radius* The minimum bending radius in the specified plane and of the appropriate flexibility-attenuation class to which a manufacturer can preform an assembly.

Clause No.	Item
	For the minimum preformed bending radius in the: — E-plane, see Table I, columns 5, 10 and 15. — H-plane, see Table I, columns 6, 11 and 16.
1.1.2.5	*Minimum field bending radius* The minimum bending radius in the specified plane and of the appropriate flexibility-attenuation class to which a straight assembly can be bent during field installation without causing mechanical damage or the electrical performance to exceed the limits specified in Table II. For the minimum field bending radius in the: — E-plane, see Table I, columns 6, 11 and 16. — H-plane, see Table I, columns 7, 12 and 17.
1.1.2.6	*Minimum repeated bending radius* The minimum bending radius in the specified plane and of the appropriate flexibility-attenuation class to which a straight assembly can be repeatedly bent (for the number of cycles specified in Table I) without causing mechanical damage or the electrical performance to exceed the limits specified in Table II. For the minimum repeated bending radius in the: — E-plane, see Table I, columns 8, 13 and 18. — H-plane, see Table I, columns 9, 14 and 19.
1.1.2.7	*Maximum field twistability* The maximum angle per unit length through which one flange of a straight twistable assembly can be rotated relative to the other flange about the centre line of the assembly during field installation without causing mechanical damage or the electrical performance to exceed the limits specified in Table II.
1.1.2.8	*Maximum repeated twistability* The maximum angle per unit length through which one flange of a straight twistable assembly can be rotated relative to the other flange about the centre line of the assembly (for the number of cyles specified in Table I) without causing mechanical damage or the electrical performance to exceed the limits specified in Table II.
1.1.2.9	*Maximum extension* The maximum permissible percentage stretch from the relaxed position to which an assembly may be subjected without causing mechanical damage or the electrical performance to exceed the limits specified in Table II.

Clause No.	Item
1.1.2.10	*Peak power rating (short term)* The theoretical breakdown value at a frequency of 1.5 times cut-off, assuming that breakdown in dry air at normal temperature and pressure (N.T.P.) occurs at 30 000 V/cm, a power safety factor of 2.25 and a voltage reflection factor of 0.2 (V.S.W.R. = 1.5) in the system under test. The duty cycle must be less than 0.001. The values given in Table II are for information only. This parameter will not normally be tested.
1.1.2.11	*Testing cycle* Flexing (or twisting) of the waveguide from the relaxed position in a plane to the extreme flexing (or twisting) position in that plane and return to the relaxed position shall constitute one cycle.
1.2	*Type designation* The reference indication for flexible waveguide assemblies covered by this specification shall comprise the following: *a)* 636 IEC — *b)* A letter corresponding to the basic construction of the assembly: T = twistable; B = non-twistable. *c)* A letter and a number characterizing the corresponding standard rigid waveguide size quoted in IEC Publication 153-2, Hollow Metallic Waveguides, Part 2: Relevant Specifications for Ordinary Rectangular Waveguides. This number indicates a frequency characteristic of the rigid waveguide size. *d)* A letter designating the flexibility-attenuation rating as in Sub-clause 1.1.2.2 and Tables I and II such as: A = Class A flexibility-attenuation. (For minimum bending radii, see columns 5 to 9 in Table I.) (For attenuation, see column 10 in Table II.) B = Class B flexibility-attenuation. (For minimum bending radii, see columns 10 to 14 in Table I.) (For attenuation, see column 11 in Table II.) C = Class C flexibility-attenuation. (For minimum bending radii, see columns 15 to 19 in Table I.) (For attenuation, see column 12 in Table II.)

Clause No.	Item
	e) Either the letter F for full bandwidth class, as in Sub-clause 1.1.1.8, or a number that denotes the centre frequency for the 15% bandwidth class, as in Sub-clause 1.1.1.9, expressed in multiples of 100 MHz. *Examples:* 636 IEC — BR100 AF denotes a non-twistable assembly having Class A flexibility-attenuation with broad-band frequency range, that will mate electrically with R100 rigid waveguide. 636 IEC — TR70 B74 denotes a twistable assembly having Class B flexibility-attenuation with a 15% frequency range centred at 7.4 GHz, so that it will mate electrically with R70 rigid waveguide.
1.3	*Standard atmospheric conditions for testing* The atmospheric conditions for testing are not critical. The following ranges may be used as a guide: Temperature range: 5 °C to 30 °C. Relative humidity: 0 to 75%.
2.	**Mechanical requirements**
2.1	*Type approval lengths* The type approval lengths given in Table I refer to the portion of the assembly that has a uniform cross-sectional jacketing area. These lengths may be increased up to 50% at the manufacturer's discretion.
2.2	*Ordering lengths* Lengths should be specified in accordance with the rules of IEC Publication 374, Guide for Choosing Modular Dimensions for Waveguide Components, unless otherwise agreed by the contracting parties.
2.3	*Assembly cross-section external dimensions* The maximum cross-sectional dimensions of an assembly shall not exceed the dimensions of the flanges fitted to the assembly.
3.	**Electrical tests**
3.1	*Attenuation* The attenuation of an agreed percentage * of assemblies shall be tested in one of the bent or twisted positions within the repeated limits of Table I at or near to the

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* The percentage of assemblies tested should be determined by prior agreement between the contracting parties.

Clause No.	Item
	approximate mid-band frequency. The manufacturer shall guarantee that equivalent electrical performance will result when the assembly is bent or twisted to all other positions within the repeated limits given in Table I. The accuracy of the measurement by the manufacturer should ensure that the attenuation per unit length of any assembly does not exceed the attenuation per unit length quoted in Table II under the appropriate flexibility-attenuation rating. (Due to the difficulties of accurately measuring the attenuation values of waveguide sizes 3 to 22 inclusive, the values in Table II for these sizes are given for information only.)
3.2	*Reflection factor* The voltage reflection factor of every assembly shall be tested in one of the bent or twisted positions within the repeated limits of Table I. The result must not exceed the value listed in Table II under the appropriate bandwidth class. Sufficient tests should be made to ensure that the voltage reflection factor does not exceed the quoted value at any point within the appropriate operating band. Agreement on tests should be reached between the contracting parties.
3.3	*Electrical leakage* For subsequent study.
4.	**Additional tests**
4.1	*Gas tightness* The assembly shall be sealed at both ends, charged with air to 1.25 times the working pressure specified in Table I and immersed in a tank of water to a depth of not more than 60 cm (2 ft). After immersion, the assembly shall be observed for a minimum period of 2 min, during which time there shall be no evidence of leakage. After removal from the tank and while still under pressure, the assembly shall be examined to make certain that there is no separation from the jacket. It is not necessary for all parts of the assembly to be submerged simultaneously. Manufacturers may elect to substitute a test other than the one specified. This is permissible providing that the contracting parties agree that equivalence is assured.
4.2	*Flexibility* Prior to the electrical test, every assembly shall be bent once in each direction in each plane to at least the appropriate minimum repeated bending radius.

Clause No.	Item
4.3	*Twistability* In addition to Sub-clause 4.2 and prior to the electrical test, every twistable assembly shall be twisted once in a clockwise and once in a counter-clockwise direction to at least the maximum angle specified for repeated twisting.
4.4	*Type approval tests*
4.4.1	*Flexibility-attenuation*
4.4.1.1	*Flexibility-attenuation at ambient temperature* *a) Field bending radius tests* The assembly shall be bent in both directions of the E plane and in both directions of the H plane to the appropriate minimum field bending radii listed in Table I for five cycles in each direction of each plane. At the conclusion of this test, the assembly shall be electrically tested whilst it is bent to the appropriate radii values given in Table I, in each direction of each plane. The electrical performance must not exceed the limits specified in Table II. *b) Repeated bending radius tests* When making this test, a machine should be used that assures the achievement of at least the minimum repeated bending radius specified in Table I for the waveguide size and class being tested. One positive way to achieve this is to bend the assembly over a rigid form. An example of a suitable machine is illustrated in Figures 1 and 2, pages 30 and 31. The machine illustrated will bend the assembly in one plane and one direction for each cycle. Such a machine can be adapted to bend the assembly alternately in both directions of one plane during each bending cycle, if so desired. An example of a machine using an alternate method for achieving similar results is illustrated in Figure 3, page 32. For certain types of construction and sizes of assembly, tests made by this method have been found to give results equivalent to those made by the previous method, even though the bending radius in the E plane is less severe than that indicated in Table I. It is considered that this equivalence results from the occurrence of simultaneous bending in both the E and H planes. The contracting parties should agree upon the acceptability of this latter test for a particular type of construction and size of waveguide. The cycling rate during the test shall range between 30 and 60 cycles per minute and the assembly under test is to be flexed in any direction of either the E or H plane or any combination thereof. The bending radii and the sum of the bends are specified in Table I.

Clause No.	Item
	At the conclusion of this test, the assembly shall be electrically tested whilst it is bent to the appropriate radii in Table I in each direction of each plane. The electrical performance of the assembly must not exceed the limits specified in Table II. It is considered that this testing period consumes the useful life of the assembly so that no additional life can be guaranteed.
4.4.1.2	*Flexibility-attenuation at other than ambient temperatures* When flexibility-attenuation tests (to either field or repeated bending radius ratings) are required at other than 20 °C, special arrangements must be made between the contracting parties.
4.4.2	*Twistability (applicable to twistable assemblies only)*
4.4.2.1	*Twistability at ambient temperature* *a) Field twisting rating tests* One flange of the assembly shall be securely fastened to a stationary platform. To prevent the assembly from bending, a rigid shaft, to be used as an axis of rotation, shall be mounted to the platform which will extend through the geometrical centre of the assembly. The other flange shall be connected to the shaft and to an eccentric mechanism which will apply to the assembly uniform alternating clockwise and counter-clockwise twisting about the axis. A means shall be provided for measuring and setting the twist angle. The assembly shall be subjected to five complete cycles of clockwise and counter-clockwise twist from the relaxed position. The twistability shall equal the maximum field twistability values given in Table I. Twisting shall be performed uniformly at a rate of approximately 1 cycle per 10 s. At the end of the test cycle, the assembly shall be under neither tension nor compression. At the conclusion of this test, the assembly shall be electrically tested whilst it is twisted in each direction at the appropriate maximum angle given in Table I. The electrical performance must not exceed the limits specified in Table II. *b) Repeated twisting rating tests* An example of a suitable apparatus is described in Sub-clause 4.4.2.1*a)*. A suitable motor shall be provided with reduction gears that permit 30 and 60 continuous cycles per minute. Counters shall be connected to record the number of twist cycles. It shall be possible to preset the mechanism to permit twisting the assembly to the angle specified. The assembly shall be subjected to the number of twist cycles specified in Table I.

Clause No.	Item
	At the conclusion of this test, the assembly shall be electrically tested in each direction at the maximum repeated twist angle given in Table I. The electrical performance must not exceed the limits specified in Table II. This testing period consumes the useful life of the assembly so that no additional life can be guaranteed.
4.4.2.2	*Twistability at other than ambient temperatures*
	Twistability tests (to either field or repeated twist ratings) required at other than 20 °C must be agreed to by the contracting parties.
4.4.3	*Field bending tests*
4.4.3.1	*Field bending test at high temperatures*
	At 20 °C, the assembly shall be bent and restrained with ties in the E plane to the minimum E-plane field radius for its flexibility-attenuation class. It shall then be placed in a 100 °C chamber and remain at that temperature for at least 24 h. (Alternatively, the temperature used for this test may be limited to a minimum of 80 °C for at least 96 h.) After this soak period, the temperature of the assembly should be reduced in less than 1 h to 20 °C. The restraining ties should be removed and the assembly straightened. The jacket shall not show signs of cracking or separation and the electrical values shall not exceed those specified in Table II.*
4.4.3.2	*Field bending tests at low temperatures*
	The test in Sub-clause 4.4.3.1 should be repeated at —50 °C.*
4.4.4	*Field twisting tests (applicable to twistable assemblies only)*
4.4.4.1	*Field twisting tests at high temperatures*
	At 20 °C, the assembly shall be twisted and restrained in the maximum field twist angle as specified in Table I. It shall then be placed in a 100 °C chamber and remain at that temperature for at least 24 h. (Alternatively, the temperature used for this test may be limited to a minimum of 80 °C for at least 96 h.) After this soak period, the temperature of the assembly should be reduced in less than 1 h to 20 °C, and the assembly straightened. The jacket shall not show signs of cracking or separation and the electrical values shall not exceed those specified in Table II.

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* Before any electrical measurements are made on the assembly, it must be thoroughly dry.

Clause No.	Item
4.4.4.2	*Field twisting tests at low temperatures* The test in Sub-clause 4.4.4.1 should be repeated at −50 °C.
4.4.5	*Hot and cold cycling tests* The ends of the specimens shall be sealed and the specimens subjected to climatic conditioning as follows: — one temperature dry heat cycle followed by five temperature dry cold cycles interjacent with six damp heat (accelerated) cycles. The cycles shall be: — temperature dry heat cycle: 16 h at 100 ± 3 °C (or 64 h at 80 ± 3 °C); — damp heat (accelerated) cycles: 16 h at 55 ± 2 °C at a relative humidity of 90% to 95%; — temperature dry cold cycles: 2 h at −55 ± 3 °C. At the conclusion of the sixth damp heat (accelerated) cycle, the specimens shall be removed from the chamber, unsealed, thoroughly dried and electrically tested. The electrical performance shall not exceed the limits specified in Table II.
4.4.6	To qualify for type approval, the manufacturer must submit proof of the following successful tests on the assemblies. 4.4.6.1 4.4.6.2 4.4.6.2*a)* 4.4.6.2*b)*
4.4.6.1	For type approval of one size, only assemblies in that size of waveguide need be tested. In this case, type approval would also apply to one size larger and one size smaller than the size submitted.
4.4.6.2	For type approval of a complete range of waveguide sizes for which approval is sought, the manufacturer must test assemblies of: *a)* the largest size in the range; *b)* the smallest size in the range; *c)* one size, near the middle of the range. Certain tests consume the useful life of an assembly; therefore the tests should be made on the assemblies as follows:

Clause No.	Item
4.4.6.2.1	*a)* For approval of non-twistable waveguides, the following tests should be performed on two assemblies. The first assembly should be tested in accordance with 4.4.1.1*a)* 4.4.3.1 4.4.3.2 4.4.5 * The second assembly should be tested in accordance with 4.4.1.1*b)*
4.4.6.2.2	*b)* For approval of twistable waveguides, the following tests should be performed on three assemblies. The first assembly should be tested in accordance with 4.4.1.1*a)* 4.4.2.1*a)* 4.4.3.1 4.4.3.2 4.4.4.1 4.4.4.2 4.4.5 * The second assembly should be tested in accordance with 4.4.1.1*b)* The third assembly should be tested in accordance with 4.4.2.1*b)*
5.	**Connection flanges** Flanges shall be fitted according to customer requirements and must be specified at the time of ordering. For type approval tests, the assemblies shall be fitted with any plain flange conforming to those detailed in IEC Publication 154-2, Flanges for Waveguides, Part 2: Relevant Specifications for Flanges for Ordinary Rectangular Waveguides, as agreed between the manufacturer and the inspection authority. Only mating features of flanges are to be specified by the user. The other dimensions must be left to the discretion of the manufacturer in order to permit economical production.
6.	**Ordering** When ordering assemblies, a customer must define the following details: *a)* the type designation as derived from Sub-clause 1.2.; *b)* the type designation of the flanges from IEC Publication 154-2; *c)* the material and finish of the terminating flanges; *d)* the length of the assembly between flange faces; *e)* if applicable, the centre frequency used (if this differs from the standard centre frequency, see Sub-clause 1.1.1.9).

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* Regardless of the order in which these tests are made, the test described in Sub-clause 4.4.5 must be the last test made.

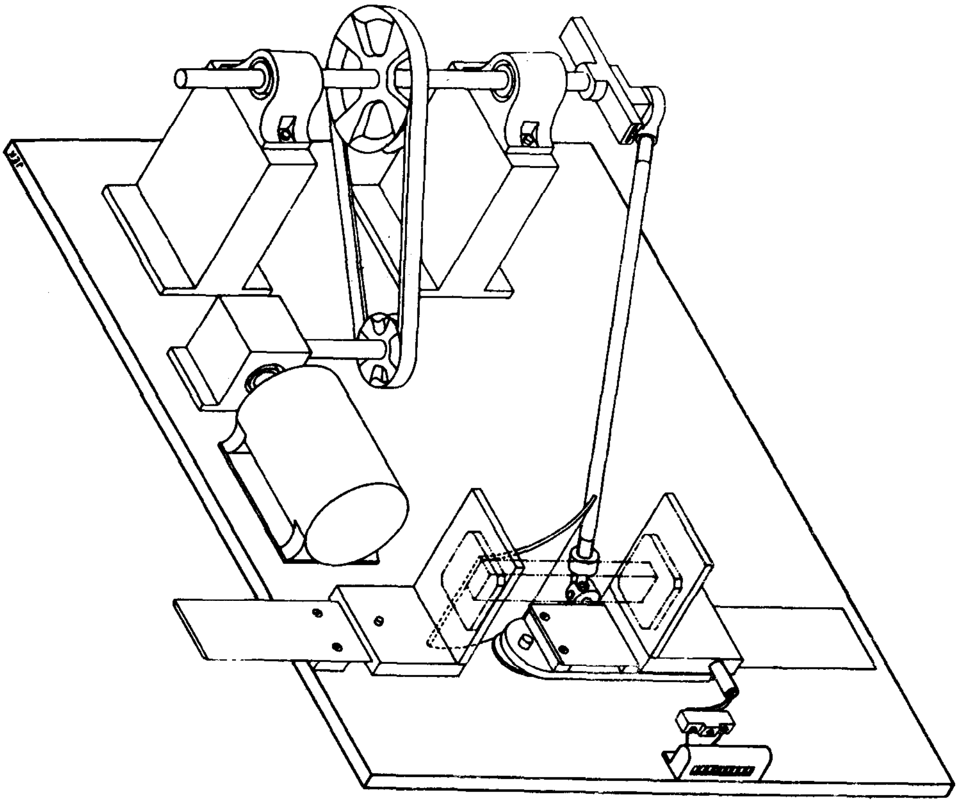
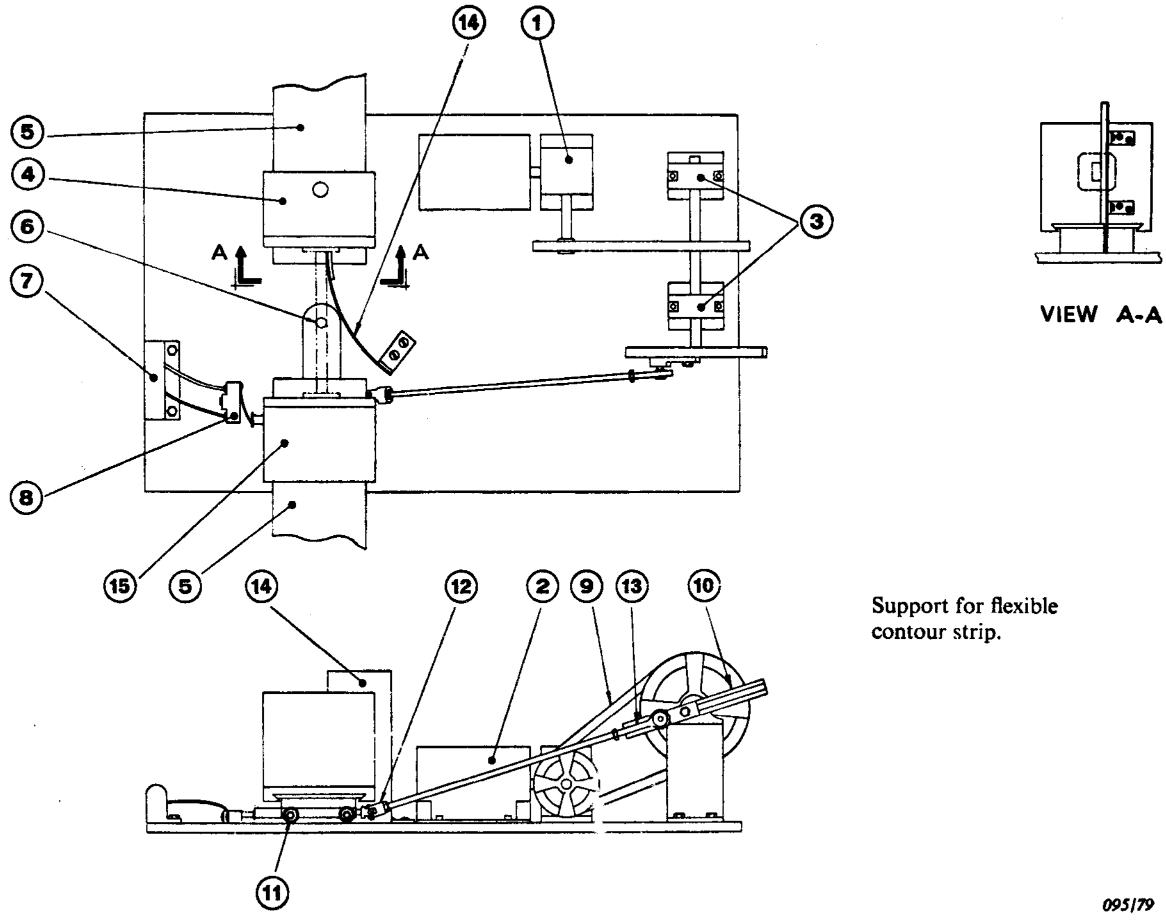


FIG. 1. — **Example of a machine for testing flexibility endurance.**



Support for flexible contour strip.

⑨ = courroie de transmission
drive belt

⑩ = réglage du débattement
throw adjustment

⑪ = roulements à billes
ball-bearing rollers

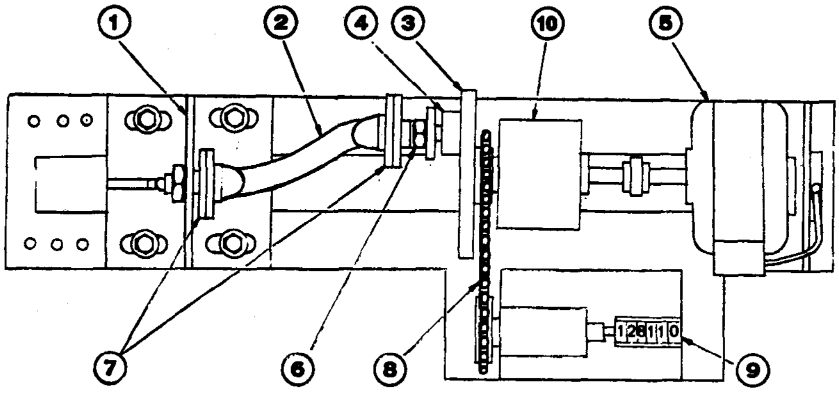
⑫ = joint de cardan
universal joint

⑬ = joint d'accouplement sphérique
spherical rod end

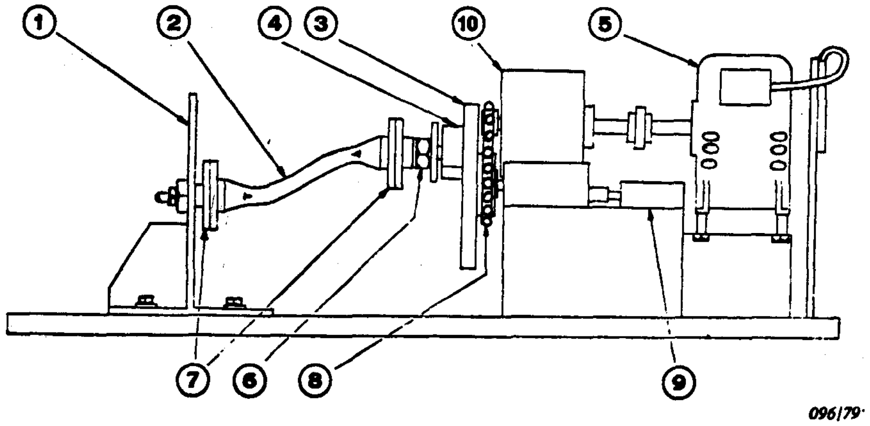
⑭ = butée de flexion du guide
contour of desired waveguide bend

⑮ = partie mobile du dispositif d'essai du guide
waveguide mounting bracket unlocked

FIG. 2. — Orthographic projection of a machine similar to that in Figure 1.



PLAN



⑥ = roulements à billes (libres, roulettes)
bearing (free running)

⑦ = fixation de la bride côté mobile de l'élément
fixed mounting for assembly flanges

⑧ = chaîne d'entraînement du compteur
chain drive to counter

⑨ = compteur
counter

⑩ = boîte à engrenages
gearbox

FIG. 3. — Example of flexing endurance test machine.

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TABLE I

MECHANICAL CHARACTERISTICS

Dimensions in millimetres

Type designation of flexible assembly		Working pressure		Minimum bending radii for: flexibility-attenuation Class A					Minimum bending radii for: flexibility-attenuation Class B					Minimum bending radii for: flexibility-attenuation Class C					Total number of repeated twisting cycles	Total number of repeated cycles per plane*	Type approval lengths	Minimum ordering lengths	Maximum ordering lengths to which the reflection factor ratings apply (see Table II, columns 6-9)	Maximum per-missible extension	Twistable assemblies only, maximum twist angle in degrees per metre	
636 IEC-		kPa	kg/cm²	*R*/2	*R*	2*R*	4*R*	8*R*	*R*/2	*R*	2*R*	4*R*	8*R*	*R*/2	*R*	2*R*	4*R*	8*R*							Instal-lation Field	Re-peated
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
TR3	BR3	20,684	0,2109	834	1 668	3 336	6 672	13 344	2 087	4 174	8 348	16 696	33 392	530	1 060	2,120	4 240	6 480	For subsequent study		3 000	150	6 000	2	For sub-sequent study	
TR4	BR4	20,684	0,2109	762	1 524	3 048	6 096	12 192	1 905	3 810	7 620	15 240	30 480	485	970	1 940	3 680	7 760			3 000	150	6 000	2		
TR5	BR5	20,684	0,2109	653	1 306	1 612	5 224	10 448	1 633	3 266	6 532	13 064	26 128	438	876	1 752	3 504	7 008			3 000	150	6 000	2		
TR6	BR6	34 474	0,3515	544	1 088	2 176	4 352	8 704	1 361	2 722	5 444	10 888	21 776	365	730	1 460	2 920	5 840			3 000	150	6 000	2		
TR8	BR8	34,474	0,3515	417	834	1 668	3 336	6 672	1 043	2 086	4 172	8 344	16 688	320	640	1 280	2 560	5 120			3 000	150	6 000	2		
TR9	BR9	34,474	0,3515	354	708	1 416	2 832	5 664	884	1 768	3 536	7 072	14 144	310	620	1 240	2 480	4 960			2 000	150	2 500	2		
TR12	BR12	34,474	0,3515	279	558	1 116	2 232	4 464	699	1 398	2 796	5 592	11 184	235	470	940	1 880	3 760			2 000	150	2 500	2		
TR14	BR14	34,474	0,3515	236	472	944	1 888	3 776	590	1 180	2 360	4 720	9 440	203	406	812	1 624	3 248			2 000	150	2 500	2		
TR18	BR18	68,948	0,7031	185	370	740	1 480	2 960	463	926	1 852	3 704	7 408	160	320	640	1 280	2 560			2 000	150	2 500	2		
TR22	BR22	103,421	1,0545	156	312	624	1 248	2 496	390	780	1 560	3 120	6 240	92	184	368	736	1 472			1 500	150	2 500	2		
TR26	BR26	132,895	1,4061	123	246	492	984	1 968	308	616	1 232	2 464	4 928	76	152	304	608	1 216			1 500	150	2 500	2		
TR32	BR32	193,053	1,9056	103	206	412	824	1 648	256	516	1 032	2 064	4 128	64	128	256	512	1 024	10^6	10^6	1 000	150	1 500	2	60	15
TR40	BR40	206,843	2,1092	83	166	332	654	1 328	208	416	832	1 664	3 328	57	114	228	456	912	10^6	10^6	600	150	1 500	2	90	21
TR48	BR48	206,843	2,1092	68	136	272	544	1 088	170	340	680	1 360	2 720	52	104	208	416	832	10^6	10^6	600	125	1 500	2	150	39
TR58	BR58	206,843	2,1092	58	116	232	464	928	144	288	576	1 152	2 304	32	64	128	256	512	10^6	10^6	600	125	1 500	2	180	45
TR70	BR70	206,843	2,1092	50	100	200	400	800	124	248	496	992	1 984	30	60	120	240	480	10^6	10^6	600	125	1 500	2	225	54
TR84	BR84	241,316	2,4607	41	82	164	328	656	102	204	408	816	1 632	24	48	96	192	384	10^6	10^6	600	50	1 500	2	255	63
TR100	BR100	310,264	3,1638	33	66	132	264	528	82	164	328	656	1 312	18	36	72	144	288	10^6	10^6	600	25	1 500	2	285	72
TR120	BR120	310,264	3,1638	27	54	108	216	432	68	136	272	544	1 088	18	36	72	144	288	10^6	10^6	300	25	1 000	2	300	75
TR140	BR140	310,264	3,1638	23	46	92	184	368	56	112	224	448	896	15	30	60	120	240	10^6	10^6	300	25	1 000	2	366	99
TR180	BR180	310,264	3,1638	19	38	76	152	304	46	92	184	568	736	12	24	48	96	192	10^6	10^6	300	25	500	2	510	129
TR220	BR220	310,264	3,1638	15	30	60	120	240	38	76	152	304	608	12	24	48	96	192	10^5	10^5	300	25	500	2	525	132
TR260	BR260	310,264	3,1638	12	24	48	96	192	31	62	124	248	496	9	18	36	72	144	10^5	10^5	150	25	500	2	540	135
TR320	BR320	310,264	3,1638	10	20	40	80	160	25	50	100	200	400	8	16	32	64	128	10^5	10^5	150	25	500	2	540	135
TR400	BR400	For subsequent study																								
TR600	BR600																									
TR620	BR620																									
TR740	BR740																									
TR900	BR900																									

* With reference to the atmosphere.

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TABLE II

ELECTRICAL CHARACTERISTICS

Type designation of flexible assembly		Normal operating frequencies (GHz)			Reflection factor				Attenuation — dB/m — flexibility-attenuation classes			Theoretical power rating in megawatts	
					Full bandwidth Class F		15% bandwidth						
636 IEC-		1,25 × f_c	1,5 × f_c	1,9 × f_c	GHz	r	MHz	r	A	B	C	1,25 f_c	1,9 f_c
1	2	3	4	5	6	7	8	9	10	11	12	13	14
TR3	BR3	0,32	0,386	0,49	0,17	0,048	26	0,015	0,005	0,003	0,003	148	210
TR4	BR4	0,35	0,422	0,53	0,18	0,048	28	0,015	0,006	0,004	0,004	124	180
TR5	BR5	0,41	0,49	0,62	0,21	0,048	32	0,015	0,008	0,004	0,004	91	132
TR6	BR6	0,49	0,59	0,78	0,28	0,048	30	0,015	0,010	0,006	0,006	63,3	91,7
TR8	BR8	0,64	0,77	0,38	0,34	0,048	51	0,015	0,015	0,007	0,007	37,2	53,8
TR9	BR9	0,76	0,91	1,15	0,39	0,048	58,5	0,015	0,010	0,010	0,010	28,8	33,8
TR12	BR12	0,96	1,15	1,46	0,50	0,048	75	0,015	0,027	0,013	0,013	17,0	34,6
TR14	BR14	1,14	1,36	1,73	0,59	0,048	68,5	0,015	0,033	0,010	0,010	11,9	17,2
TR18	BR18	1,45	1,74	2,20	0,76	0,048	115	0,015	0,046	0,023	0,023	14,3	20,6
TR22	BR22	1,72	2,06	2,01	0,89	0,048	134	0,015	0,059	0,029	0,029	5,2	7,5
TR26	BR26	2,27	2,61	3,30	1,13	0,048	170	0,015	0,082	9,038	0,038	3,1	4,5
TR32	BR32	2,60	3,12	3,95	1,35	0,048	203	0,015	0,105	0,052	0,052	2,2	3,3
TR40	BR40	3,22	3,17	4,90	1,68	0,048	252	0,015	0,151	0,071	0,071	1,8	2,8
TR48	BR48	3,94	4,73	5,99	2,05	0,048	308	0,015	0,187	0,080	0,090	1,4	2,0
TR58	BR58	4,64	5,57	7,05	2,41	0,048	362	0,015	0,240	0,114	0,114	0,60	0,20
TR70	BR70	5,38	6,46	8,17	2,79	0,048	419	0,015	0,299	0,142	0,142	0,56	0,71
TR84	BR84	6,37	7,82	9,99	3,42	0,048	513	0,019	0,394	0,184	0,184	0,33	0,46
TR100	BR100	8,20	9,84	12,50	4,30	0,048	645	0,019	0,525	0,249	0,249	0,20	0,28
TR120	BR120	9,84	11,8	15,0	5,16	0,048	774	0,019	0,656	0,319	0,319	0,18	0,20
TR140	BR140	11,9	14,2	16,0	6,1	0,070	915	0,029	0,853	0,394	0,394	0,12	0,10
TR180	BR180	14,5	17,4	17,4	7,5	0,070	1 125	0,029	1,15	0,551	0,551	0,085	0,100
TR220	BR220	17,6	21,1	26,7	9,1	0,070	1 385	0,029	1,51	0,637	0,637	0,045	0,058
TR260	BR260	21,7	26,1	33,0	11,9	0,083	1 495	0,048	2,80	0,944	0,944	0,031	0,043
TR320	BR320	26,4	31,6	40,0	13,6	0,083	2 040	0,048	3,62	1,272	1,272	0,022	0,030
TR400	BR400	32,9	39,5	50,1	17,2	For subsequent study	2 580	For subsequent study					
TR500	BR500	39,2	47,1	69,6	20,4		3 580						
TR620	BR620	49,8	59,9	75,8	26.0		3 900						
TR740	BR740	60,5	72,6	91,9	31,4		4 710						
TR900	BR900	73,6	68,6	112,0	34,2		5 130						

Printed at Dee Kay Printers, New Delhi, India